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VK1650 Datasheet

8×4 LED DRIVER

Rev.1.3

1 General Description

VK1650 is a dedicated chip for LED driver control with a keyboard scanning circuit interface. It integrates circuits such as a data latch, LED driver, and keyboard scanning internally. The SEG pin is connected to the anode of the LED, and the GRID pin is connected to the cathode of the LED, which can support 8SEG×4GRID dot matrix LED display. Supports up to 7x4 keys at most. This chip features stable performance, reliable quality and strong anti-interference ability. It is suitable for applications that require continuous operation for 24 hours. It adopts SOP16 and DIP16 packaging forms.

2 Key Features

- Operating voltage：3.0-5.5V
- Built-in RC oscillator
- 8 SEG pins, 4 GRID pins
- The SEG pin can only be connected to the anode of the LED, and the GRID pin can only be connected to the cathode of the LED
- 7×4 matrix keys do not support combination keys
  (Key display multiplexing requires hardware circuit coordination)
- 2-wire serial interface
- The overall brightness is adjustable at 8 levels
- The built-in display RAM is 8×4 bits
- Built-in power-on reset circuit
- Available Packages:
  SOP16(150mil)(9.90m × 3.90mm PP=1.27mm)

3 Application Field

- Small household appliances
- Induction cooker/microwave oven
- Pressure gauge

4 Product Selection

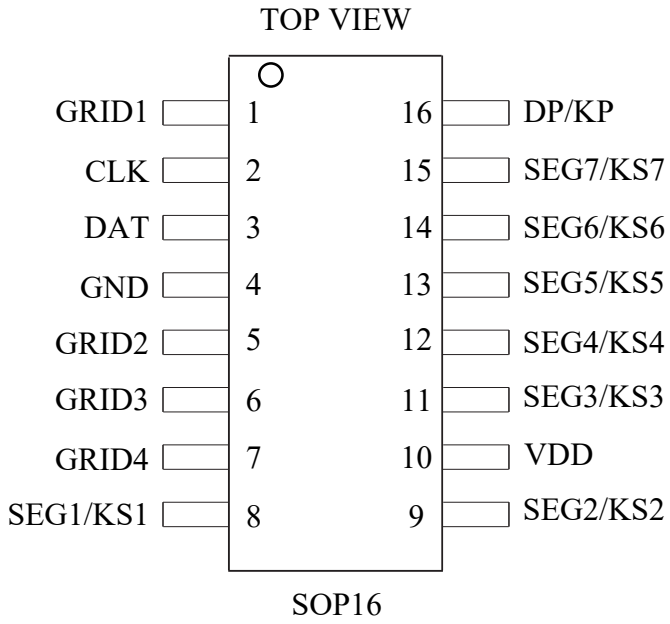
Part No.	Communication interface	Drive lattice	Common Cathode Drive	Common Anode Drive	Key press	Packaging
VK1640	CLK/DIN	128	8 / 16	16 / 8	---	SOP28
VK1640A	CLK/DIN	128	8 / 16	16 / 8	---	SSOP28
VK1640B	CLK/DIN	96	8 / 12	12 / 8	---	SSOP24
VK1Q60	CLK/DIN	32	8 / 4	4 / 8	7×4	QFN16L (3×3mm)
VK1650	CLK/DAT	32	8 / 4	4 / 8	7×4	SOP16
VK1651	CLK/DIO	28	4 / 7	7 / 4	7×1	SOP16

Note: Except for VK1651, for all other common cathode/common anode digital tubes, SEG is connected to the anode and GRID to the cathode.
The SEG of VK1651 is connected to the cathode and the GRID to the anode.

5 Ordering Information

Part No.	Packaging	Tube Qty	Tray(reel) Qty	Box Qty	Total Qty	Notes
VK1640	SOP28	26/tube		2080/box	20800 PCS	
VK1640A	SSOP28	50/tube		5000/box	50000 PCS	
VK1640B	SSOP24	50/tube		10000/box	100000 PCS	
VK1Q60	QFN16L (3×3mm)		3000/reel	30000/box	120000 PCS	
VK1650	SOP16		4000/reel	16000/box	96000 PCS	
VK1651	SOP16	50/tube		10000/box		

6 Package Pinout Information(SOP16)



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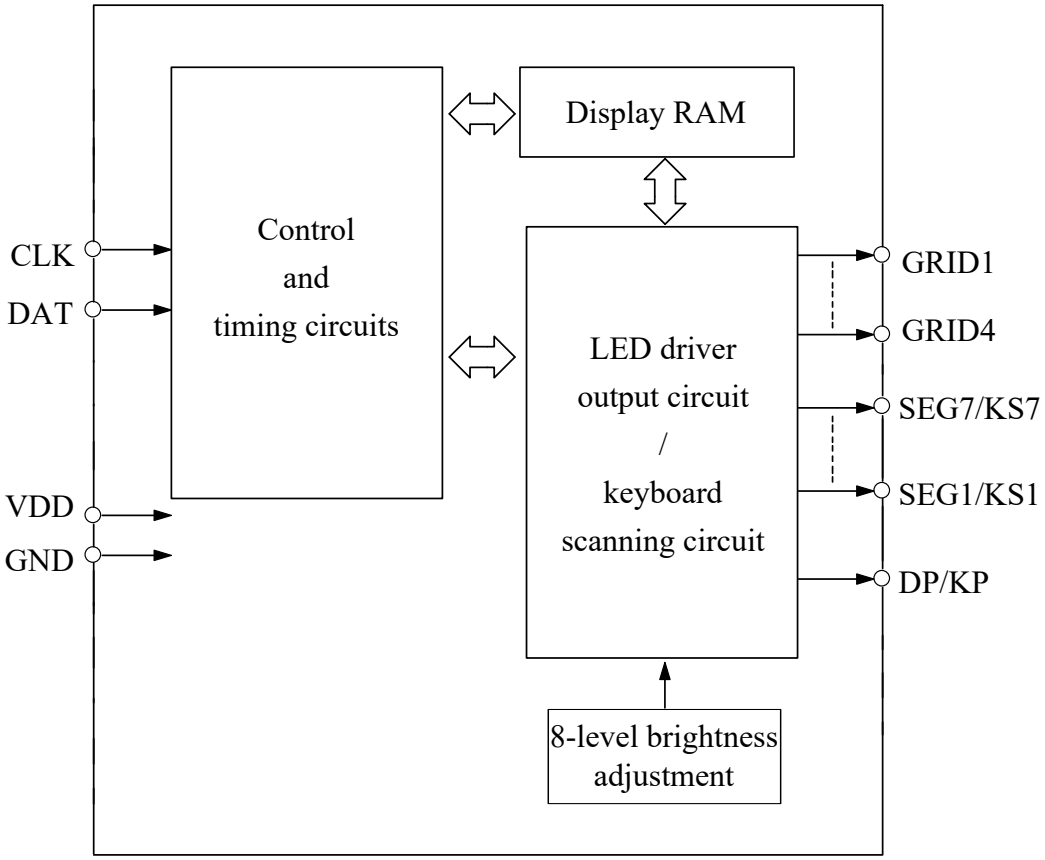
6.1 VK1650/SOP16 Pin Description

No.	Name	I/O	Function
1,5-7	GRID1-GRID4	O	LED GRID output (N-tube leakage open); Key scan output
2	CLK	I	The data clock input of the serial interface is equipped with an internal pull-up resistor
3	DAT	I/O	The data input and output of the serial interface are equipped with built-in pull-up
4	GND	GND	Negative power supply
8,9, 11-15	SEG1/KS1-SEG7/KS7	I/O	LED SEG driver output, high level effective, also used as key scan input, high level effective, built-in pull-down
10	VDD	VDD	Positive power supply
16	DP/KP	O	LED SEG output, also used as keyboard icon output

7 Functional Description

7.1 Block Diagram



7.2 Display RAM- Storage Structure

The static display memory (RAM) has an 8× 4-bit structure and stores the displayed data. The content of RAM is directly mapped to the display content of the LED driver, with display addresses of 0x68,0x6A,0x6C, and 0x6E, totaling four display units. If you want to turn on or off a certain LED, simply set the corresponding display RAM position 1 or clear 0. For example, to control the on/off of LED1 driven by pins SEG1 and GRID1, simply set the corresponding display RAM (address 0x68) Bit0 position 1 or clear 0. Clear the RAM bits corresponding to the unused SEG pins in the application to 0.

The process of mapping the contents in RAM to leds is shown in the following table:

SEG GRID	DP	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	Addr
GRID1									0x68
GRID2									0x6A
GRID3									0x6C
GRID4									0x6E
	D7	D6	D5	D4	D3	D2	D1	D0	

Note:

1. The value stored inside the chip display RAM at the moment of power-on may be random. It is recommended that the customer perform a power-on reset of the display RAM, that is, write all the data 0x00 to the 4-byte display RAM(address 0x68,0x6A,0x6C,0x6E) after power-on.
2. The SEG pin can only be connected to the anode of the LED, and the GRID pin can only be connected to the cathode of the LED. They must not be reversed.

7.3 Keyboard Scanning

The keyboard scan codes corresponding to VK1650 are shown in the following table:

Addressee	GRID4	GRID3	GRID2	GRID1
SEG1/KS1	47H	46H	45H	44H
SEG2/KS2	4FH	4EH	4DH	4CH
SEG3/KS3	57H	56H	55H	54H
SEG4/KS4	5FH	5EH	5DH	5CH
SEG5/KS5	67H	66H	65H	64H
SEG6/KS6	6FH	6EH	6DH	6CH
SEG7/KS7	77H	76H	75H	74H

Note: When using the key function, a 2KΩ resistor needs to be connected in series at the GRID pin. Combination keys are not supported.

8 Serial Communication Commands

8.1 Communication Interface

The VK1650 has two communication pins. Two-wire serial communication is adopted.

The CLK pin is the clock input pin. Data is written to the display RAM at the rising edge, and DIO pin data is read out at the rising edge.

The DAT pin is a serial data input pin, which is used for data input and output of the serial interface and has an inbuilt upper open leakage mode.

The starting condition for data input is that when CLK is at a high level, DAT decreases from high to low. The termination condition is that when CLK is high, DAT changes from a low level to a high level.

ACK signal: If the communication is normal, at the 8th clock falling edge of the serial communication, the VK1650 pulls down the DAT. DAT is released as input until the 9th rising edge of the clock is detected.

8.2 Command Description

The command is a 2-byte command, with the high byte being the command and the low byte being the set parameter, the written display data or the returned key value.

There are three types of high-byte commands:

I. System Settings Command -- used to configure parameters
II. Write Display Data Command - used for writing display data.
III. Read Key Commands - Used to read key values.

	High-byte command									Low byte parameters or data									
Start	C7	C6	C5	C4	C3	C2	C1	C0	Ack	D7	D6	D5	D4	D3	D2	D1	D0	Ack	Stop

8.3 System Settings Commands

This command is used to turn the display on and off, set the display mode, display brightness and sleep.

		MSB							LSB		
Function	Byte	B7	B6	B5	B4	B3	B2	B1	B0	Note	
Command	1st	0	1	0	0	1	0	0	0	System Settings Command	
Command	2nd	0	0	0	0		0	0		Brightness setting	8 levels of brightness
			0	0	1		0				1 levels of brightness
			0	1	0		0				2 levels of brightness
			0	1	1		0				3 levels of brightness
			1	0	0		0				4 levels of brightness
			1	0	1		0				5 levels of brightness
			1	1	0		0				6 levels of brightness
			1	1	1		0				7 levels of brightness
						0	0			7/8 display control bits	8SEG display mode
						1	0				7SEG display mode
			0	0	0	0	0		0	Turn on/off the display bit	Off display
							0		1		On display
			0	0	0	0	1		0		Activate sleep mode

8.4 Write Display Data Commands

The display data write commands 0x68-0x6E respectively write data to the corresponding digital tube positions GRID1-GRID4, with each 1Bit of display data corresponding to 1 SEG.

		MSB							LSB	
Function	Byte	D7	D6	D5	D4	D3	D2	D1	D0	Note
Write the command to display data	1st	0	1	1	0	1	0	0	0	0x68 Write the display data to the digital tube position GRID1
		0	1	1	0	1	0	1	0	0x6A Write the display data to the digital tube position GRID2
		0	1	1	0	1	1	0	0	0x6C Write the display data to the digital tube position GRID3
		0	1	1	0	1	1	1	0	0x6E Write the display data to the digital tube position GRID4
Display data	2nd	X	X	X	X	X	X	X	X	Display data: bit7-DP, bit6-SEG7,... bit0-SEG1

8.5 Read Key Commands

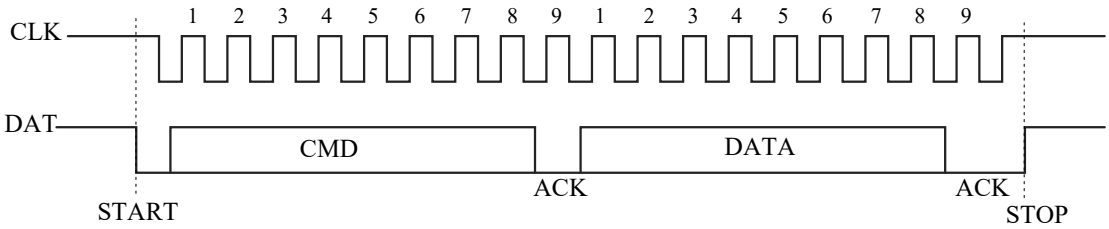
This command is used to read the key values. The keys only support single keys and do not support multiple keys being pressed simultaneously.

		MSB							LSB	
Function	Byte	B7	B6	B5	B4	B3	B2	B1	B0	Note
Command	1st	0	1	0	0	1	1	1	1	Read the key command
Key value	2nd	X	X	X	X	X	X	X	X	Press the button to scan the code value

9 Command Timing

9.1 Write Display The Data Timing Sequence

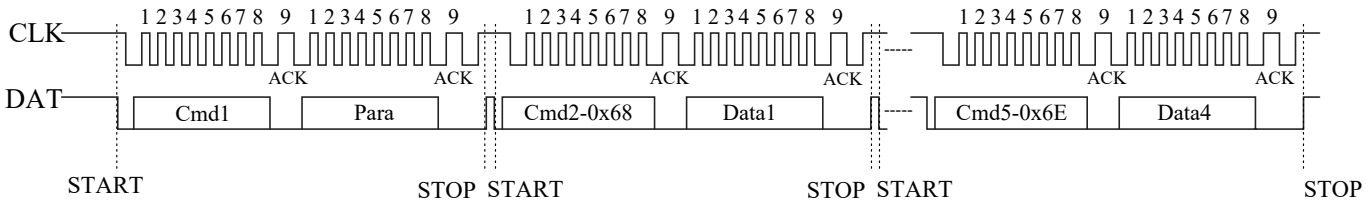
First, write the display data command (0x68-0x6E). After the command is sent, transfer 1 byte of display data.



CMD: Write the display data command ->0x68-GRID1,0x6A-GRID2,0x6C-GRID3, 0x6E-GRID4

DATA: Write display data ->bit7-DP,bit6-SEG7,... bit0-SEG1

9.2 System Settings + Write Display Data Timing



Cmd1: System Settings Command.

Para: Display Parameters -> Open Display, set the number of LED display segments, set the display brightness level.

Cmd2: Write the display data command 0x68.

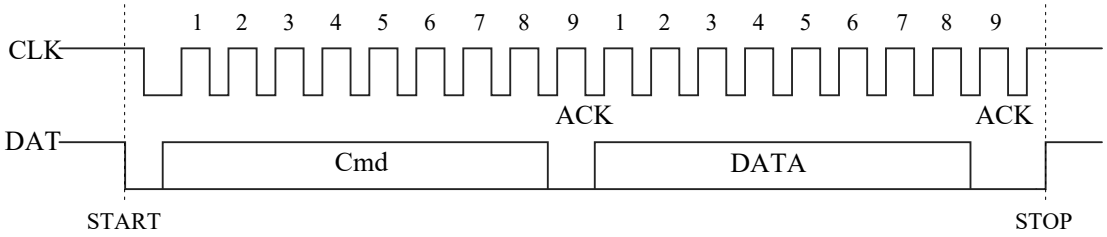
Data1: Send display data to GRID1.

...

Cmd5: Write the display data command 0x6E.

Data4: Send display data to GRID4.

9.3 Read Key Timing Sequence

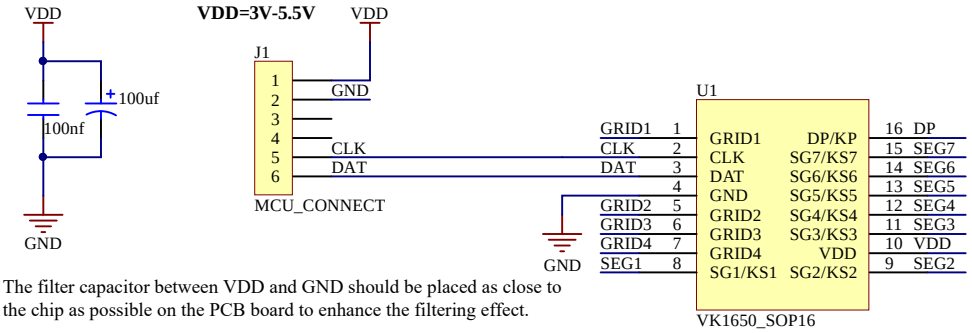


Cmd: Send the read key scan command (0x4F).

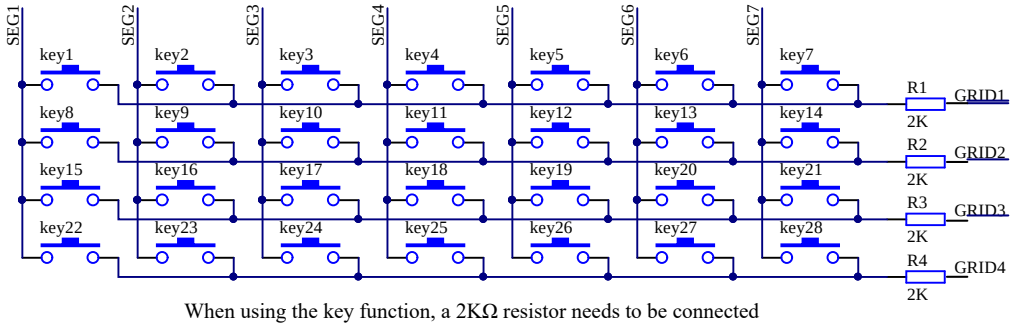
DATA: The key scan data read.

10 Application Circuits

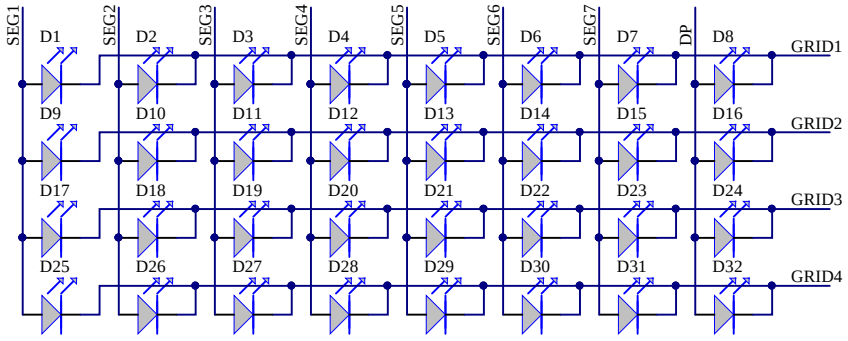
When the surrounding interference is relatively large, a 10R to 1k resistor and a PF-level small capacitor to ground can be connected in series on the communication pin. When the power supply of the single-chip microcomputer (3.3V) and the driver chip (5V) is inconsistent, it is recommended to add a level conversion circuit on the communication pin



The filter capacitor between VDD and GND should be placed as close to the chip as possible on the PCB board to enhance the filtering effect.



When using the key function, a 2KΩ resistor needs to be connected in series with the GRID pins. Combination keys are not supported.



Connect the SEG pin to the anode of the LED and the GRID pin to the cathode of the LED

11 Electrical Characteristics

11.1 Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
Supply voltage	VDD	-0.5～+6.5	V
Input Voltage	VIN	V_{SS}-0.5～V_{DD}+0.5	V
Storage Temperature	T_{STG}	-55～+125	℃
Operating Temperature	T_{OTG}	-40～+85	℃

11.2 DC Electrical Characteristics

Test conditions：Ta = 25℃，VDD =5V

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Operating voltage	VDD	3	5	5.5	V	—
Static current	I_{DD}	—	80	150	mA	—
Static current	IC_s	—	0.3	0.6	mA	CLK、DAT、KP High level
Sleep current	IC_{slp}	—	0.05	0.1	mA	CLK、DAT、KP High level
High-level output current	I_{OHSEG}	—	-25	—	mA	VO=VDD-2V SEG1-SEG7,DP
Low-level output current	I_{OLGRID}	—	150	—	mA	VO=0.3V GRID1-GRID4
Low-level Input	VIL	0	—	0.2	VDD	CLK、DAT
High-level Input	VIH	0.7	—	1	VDD	CLK、DAT
Input low voltage1	VIL_{ki}	-0.5	—	0.5	V	KS
Input high voltage1	VIH_{ki}	1.8	—	VDD+0.5	V	KS
Input low voltage1	VOL_{dig}	—	—	1.2	V	GR Pin current-200mA
Input low voltage2	VOL_{dig}	—	—	0.8	V	GR Pin current-100mA
Input high voltage2	VOH_{dig}	4.5	—	—	V	GR Pin current5mA
Input low voltage3	VOL_{ki}	—	—	0.5	V	KS Pin current-20mA
Input high voltage3	VOH_{ki}	4.5	—	—	V	KS Pin current20mA
Input pull-down current	I_{DN1}	-30	-50	-90	uA	KS
Input pull-up current	I_{UP1}	100	200	300	uA	CLK
Input pull-up current	I_{UP2}	150	300	400	uA	DAT
Input pull-up current	I_{UP3}	500	2000	5000	uA	KP
Power-on reset voltage	V_R	2.3	2.6	2.9	V	POR

11.3 AC Electrical Characteristics

Internal timing parameters (test conditions: Ta = 25℃, VDD =5V)

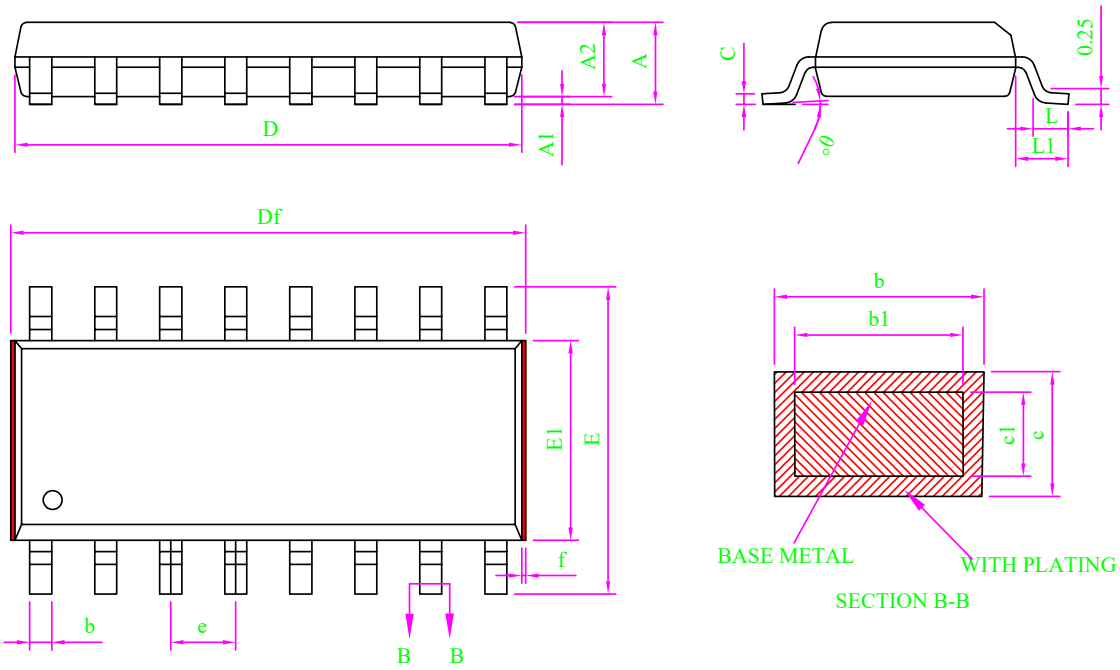
Parameter	Symbol	Min.	Typ.	Max.	Unit
Power-on reset time	T_{PR}	10	25	60	ms
Display the scanning cycle	T_P	4	8	20	ms
Key response time	T_{KS}	20	40	80	ms

Serial communication parameters (test conditions: Ta = 25℃, VDD =5V)

Parameter	Symbol	Min.	Typ.	Max.	Unit
The establishment time of the DAT falling edge start signal	T_{SSTA}	100			ns
The holding time of the DAT falling edge start signal	T_{HSTA}	100			nS
The establishment time of the DAT rising edge stop signal	T_{SSTO}	100			ns
The holding time of the DAT rising edge stop signal	T_{HSTO}	100			ns
The low-level width of the CLK clock signal	T_{CLOW}	100			nS
High-level width of the CLK clock signal	T_{CHIG}	100			nS
The DAT input data establishes the time for the rising edge of CLK	T_{SDA}	30			nS
The DAT input data establishes the time for the rising edge of CLK	T_{HDA}	10			nS
The DAT output data effectively delays the CLK falling edge	T_{AA}	2		30	nS
Invalid DAT output data delays the falling edge of CLK	T_{DH}	2		40	nS
Average data transmission rate	R_{ate}	0		M	bps

12 Package Information

12.1 SOP16(9.9mm × 3.9mm PP=1.27mm)



Note:

1. All dimension are in mm.
   Dim D&El does not include plastic flash; Df includes plastic flash(f);
   Flash: Plastic residual around body edge after de junk/singulation.
2. Dim b does not include dambar protrusion/intrusion.
3. Plating thickness 0.007mm-0.020mm

MILLIMETER			
SYMBOL	MIN	NOM	MAX
A	-	-	1.75
A1	0.10	0.15	0.20
A2	1.35	1.45	1.55
b	0.39	-	0.47
b1	0.38	0.41	0.43
c	0.20	-	0.25
c1	0.19	0.20	0.21
D	9.80	9.90	10.00
Df	9.90	-	10.40
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
L	0.51	0.66	0.81
L1	0.95	1.05	1.15
θ	0	-	8°
f	0.05	-	0.20

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14 Revision History

No.	Version	Date	Modify the content	Check
1	1.0	2018-08-10	Initial release	YES
2	1.1	2018-10-11	Add reference circuit	YES
3	1.2	2019-03-21	Alignment correction	YES
4	1.3	2025-10-16	Change Description	YES

[1] Please refer to the latest version of this document before starting or finalizing any design.

[2] Since the release of this document, the status or availability of this product may have changed. For the most up-to-date information, please visit: https://www.szvinka.com/